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Fractures and Dislocations of the Ankle Joint

A. P. FERREIRA,  I. S. DE WET,  G. F. DOMMISSE

SUMMARY

The classification of fractures of the ankle joint is based on the mechanism of injury, which provides the clue to successful reduction. The physiological movements of the ankle and foot are defined, and the pathological movements associated with injury are described.


'Without theory, practice is but a routine born of habit. Theory alone can bring forth and develop the spirit of invention'.

L. Pasteur

There are many bones of contention, and almost as many classifications of injury as there are bones in the ankle and foot. The problems are not far to seek, first among them the basis of the classification. We reject an anatomical basis as practically unsound, and we believe that only those classifications which are based on the mechanism of injury can and should survive. The three major contributors in this respect have been Ashhurst and Bromer,8 Bonnin,9 and Lauge-Hansen.10 For reasons described below, we advise and indeed use the classification of Bonnin.9

Department of Orthopaedics, University of Pretoria and Orthopaedic Hospital, Pretoria

A. P. FERREIRA, M.B., CHB
I. S. DE WET, M.B., B.CH., M.CH
G. F. DOMMISSE, M.D., CH.M., F.R.C.S.

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Other problems are terminology on the one hand, and the complicated movements of the foot relative to the leg on the other. In these movements, both normal and forced, the ankle joint, the subtaloid joint and the midtarsal joint are all involved in varying degrees. Unless and until uniformity and unanimity of terminology are achieved, confusion and ambiguity will persist. (Stated more simply, the movements of the ankle, the hindfoot and the forefoot must be considered.)

In the past, there were those who made their contributions. Notable among the early workers were Percival Pott (1714 - 1788), Sir Astley Cooper (1768 - 1841), both of England, Dupuytren (1777 - 1835), Maisonneuve (1809 - 1897) and Destot of France, Ashhurst and Bromer of the USA and many others. 'Destot's book Traumatismes du Pied et Rayons-X, published in 1911, was the first monograph in which the evidence provided by radiography (discovered by Roentgen in 1895) was considered. This book still remains the French authority ...' The myth of Pott's fracture survives to the present day.

WHAT IS POTT'S FRACTURE?

Percivall Pott12 was the first major British surgeon to publish his views on ankle fractures. He wrote the article while convalescing from a fractured tibia and fibula. He did not himself suffer from 'Pott's' fracture. Misunderstanding has arisen, some no doubt due to the comment of Ashhurst and Bromer13 who wrote: 'Pott (1768) described a fracture which does not exist, and Dupuytren (1819) commended him for his acute observation and fidelity to
nature. Cooper (1822), more sensible than either, merely recounted what he had seen, avoided speculation about what he had not seen, and was silent on subjects about which he had no knowledge. This was harsh comment, more particularly when one recalls that neither Pott nor Dupuytren enjoyed the advantages of Roentgen's discovery. Pott's fracture bears a close resemblance to Dupuytren's fracture and to abduction fractures described below. Pott, who based his work on clinical findings, failed to recognize diastasis at the distal tibiofibular syndesmosis. The fact is that today no basis for Pott's classification of ankle fractures exists. His work is of historical interest, and as such it is held in high esteem.

WHO WAS MAISONNEUVE AND WHAT IS MAISONNEUVE'S FRACTURE?

Maisonneuve's fracture is illustrated in Fig. 2. The contribution of this worker was much greater than this rather rare fracture which bears his name. Maisonneuve was the first to recognize that external rotation of the foot on the vertical axis of the leg (the tibia) is the manner in which the majority of ankle fractures occur, and that although people often twist their ankles inwards beneath them, this latter mechanism results in ligament tears, rather than in fractures.

It is a pity so little is known about Maisonneuve, whose contribution was of fundamental significance. He was a pupil of Dupuytren, who, in the classic manner, became greater than his master. Bonnin pays him this tribute: '... a genius, who soon became critical of his own masters and did not hide his dissatisfaction. A taste for polemics together with a determination to maintain his own point of view, soon had him at loggerheads with most of his colleagues ...' The lot of an intellectual rebel is not a pleasant one ... for much Maisonneuve had only himself to blame. He was a fearless man.'
Maisonneuve's work is described by Bonnin as being: 'as fresh today as when first written'. In this work, 'he made the much criticised comparison of the ankle to a mortise and tenon joint (Fig. 4), and then the action of abduction and external rotation violence is considered'.

DEFINITIONS

External rotation (outward or lateral rotation). This is illustrated in Fig. 5 and described by Bonnin' as: 'Lateral rotation of the foot in a horizontal plane around a vertical axis'.

Internal rotation. Medial rotation of the foot on a vertical axis, in a horizontal plane.

Eversion. This is a complicated term which describes both position and form of the foot. Both the hindfoot and the forefoot are involved, and it is this factor which has led to confusion. The four components of eversion are: (i) fibular flexion* (synonym: abduction of hindfoot); (ii) external rotation of the foot; (iii) dorsiflexion of the ankle joint; and (iv) pronation of the forefoot. Understanding of the components of eversion and of the implications of forced eversion is essential for the study of ankle fractures and classification.

Inversion. The diametric opposite of eversion, thus: (i) tibial flexion* (adduction of the hindfoot); (ii) internal rotation of the foot on a vertical axis; (iii) plantar flexion of the ankle joint; and (iv) supination of the forefoot.

Supination. Movement of the forefoot on a sagittal (longitudinal) horizontal axis of the foot, with movement in a cranial direction of the first metatarsal and in a caudal direction of the fifth metatarsal. The sole of the foot faces inward.

Pronation. The diametric opposite of supination.

Abduction. There is much confusion about this term, which is used here in the context of an abnormal force acting on the ankle, resulting in a fibular flexion of the talus within the ankle mortise. Normally, abduction or fibular flexion of the hindfoot occurs at the subtalar joint, and at the ankle joint only when there is full plantar flexion.

Adduction. A force producing abnormal tibial flexion of the talus within the ankle mortise; the opposite of abduction. Kapandji* states: 'Thus, barring any compensatory movements occurring at joints outside the foot, abduction can never be associated with pronation and, adduction can never be associated with supination. Therefore there are in the foot forbidden combinations of movement resulting from the very structure of its joints'. Lauge-Hansen** classifies fractures among others as being due to 'supination-eversion', a movement which, according to Kapandji* and in our own experience, is impossible.

SIGNIFICANCE OF EXTERNAL ROTATION OF THE FOOT

Bonnin* explains: 'It is remarkable that the most common form of violence affecting the ankle (external rotation), and responsible for 70 percent of the indirect traumatic lesions afflicting the joint, should be the most neglected in the average text. The difference between external rotation and internal rotation as it affects the flexibility of the foot has been described. In external rotation the foot passes into slight eversion and becomes a rigid lever (Fig. 6).

A mechanical pressure is developed on the leading edge of the lower end of the fibula, and this is supplemented by the pull of the posterior talo-fibular ligament. The fact that the pressure would be maximal over the anterior edge of the fibula was shown long ago by Maisonneuve's experiment of the two books (Fig. 4) and can easily be deduced theoretically.'

In external rotation of the foot relative to the ankle joint mortise, the foot is a long rigid lever, the medial malleolus is the fulcrum upon which the system pivots, and the leading edge of the lower end of the fibula bears the load. It yields more commonly in the form of a fracture distal to the tibiofibular syndesmosis (Fig. 3), less commonly in the form of 'division' of the fibula from the tibia, with consequent tibiofibular diastasis (Fig. 6).
Fig. 6. On external rotation of the foot about a vertical axis, maximum pressure is on the anterior part of the fibula.

WHAT CLASSIFICATION?

A classification is preferable to a catalogue, and for this reason we shall exclude fractures of the talus and confine ourselves to the ankle joint, as described by Bonnin, and selected in terms of the mechanism of injury.

As a prelude to classification, we repeat the definition of diastasis at the distal tibiofibular syndesmosis, because an appreciation of diastasis is fundamental to the study: Diastasis is any loosening of the attachments of the tibia and fibula at the syndesmosis, not necessarily demonstrable on routine radiographs but clearly displayed when special ‘stress’ tests are done. There are three stages: first-stage diastasis: rupture of anterior or posterior tibiofibular ligament, or fracture of the anterior or the posterior tubercle of the tibial notch; second-stage diastasis: as for 1st degree, but with rupture also of the interosseous tibiofibular ligament; and third-stage diastasis: total rupture of all the ligaments, i.e. a combined 1st- and 2nd-degree tear.

According to Bonnin’s classification, the four major types are those due to: external rotation violence; abduction violence; adduction violence; and compression violence (proximodistal).

External Rotation Injuries

This group comprises 70% of ankle fractures.

1st degree. Mixed oblique fractures of the fibula (Destot), without diastasis at the distal syndesmosis. In this group are included various types of oblique fractures of the distal part of the fibula, depending on the direction of force, whether pure external rotation or rotation combined with abduction. Alternately, Maisonneuve’s fracture of the proximal end of the fibula (Fig. 2), with associated diastasis in the 1st stage. In each of the above, there is rupture of the medial (deltoid) ligament in greater or lesser degree.

2nd degree. Mixed oblique fracture of fibula combined with oblique fracture of medial malleolus, without diastasis, or fracture of fibula in distal third (high Dupuytren’s fracture) combined with oblique fracture of medial malleolus plus tearing of anterior tibiofibular ligament giving rise to diastasis, second stage. There may be an associated fracture of the posterior tubercle of the fibular notch of the tibia (Fig. 7).

Fig. 7. Second-degree, external rotation fracture. Anteroposterior and lateral view.

3rd degree. As in 2nd degree, but with the addition of posterior marginal fracture of the tibia, or dislocation of the talus. The essential feature of 3rd degree injuries is instability (loss of support by the tibia) in all three planes of deformity, namely external rotation, lateral slide and proximal displacement. There is second-to-third-stage diastasis (Fig. 8).

Fig. 8. Third-degree external rotation fracture. Lateral view.

Abduction Injuries

Normal abduction takes place at the subtaloid joint. Abnormal abduction is an impure movement and consists of abduction together with lateral slide. ‘Lateral abduction is the dominant element in many abduction fractures and in some cases of diastasis.'
1st degree. Transverse (avulsion) fracture of the medial malleolus, or transverse fracture of the lateral malleolus distal to the tibial plafond (horizontal weight-bearing surface). In this case, the deltoid ligament is torn, and diastasis is absent.

2nd degree. Transverse fracture of both malleoli distal to the tibial plafond, without diastasis, or fracture of the medial malleolus distal to the plafond, and of the fibula proximal to the tibial joint surface. Diastasis is present. This is a 'low Dupuytren fracture' (Fig. 9).

3rd degree. Bimalleolar fractures distal to the plafond, plus posterior marginal fracture of the tibia (without diastasis), or fracture of the fibula just proximal to the plafond (low Dupuytren) plus displacement of the talus together with the distal fibular fragment, or high fracture of fibula plus fracture of the medial malleolus plus total diastasis.

Adduction Injuries

Adduction at the ankle (also referred to as tibial flexion) occurs in association with internal rotation of the foot relative to the tibia. During internal rotation, the foot also goes into adduction. Internal rotation alone does not produce fractures. When internal rotation and adduction reach significant proportions, they result in fractures of which Bonnin' says: 'Medial slide of the talus is the dominant element . . .'.

There are thus two important components of the pathologically directed force, namely: tibial flexion, and medial slide of the talus. Diastasis of the distal tibiofibular syndesmosis is not a feature.

1st degree injuries. Vertical fracture of the medial malleolus, or transverse fracture of the lateral malleolus at the level of the tibial plafond (avulsion injury).

2nd degree injuries. A bimalleolar lesion comprising both injuries listed above (Fig. 10).

3rd degree injuries. As in 2nd degree, but with the addition of posterior marginal fracture of the tibia, subluxation or dislocation of the talus.

Compression Injuries

Compression or axial force is the dominant factor, probably the only factor, with destruction of the tibial plafond in greater or lesser measure. It should be noted that in all other mechanisms of injury, compression is also a factor, more particularly in 3rd-degree lesions. The injuries of compression are: (i) posterior marginal fracture; (ii) anterior marginal fracture; (iii) medial marginal fracture; (iv) lateral marginal fracture; and (v) comminution of the tibial plafond. This completes the classification.

CONTROVERSIAL ISSUES

The definitions offered above of the various movements of the foot and ankle, and the terms used to describe them, are those which are offered and used by most surgeons and anatomists who have made their contributions. Some fundamental differences between Bonnin and Lauge-Hansen require special mention: Lauge-Hansen defines supination as a combined movement consisting of inward rotation and adduction of the hindfoot and inversion of the forefoot. By the same token he defines pronation as a combined movement consisting of outward rotation and abduction (hindfoot) and eversion of the forefoot. Bonnin's use of terms has already been defined. Hoppenfeld' reserves inversion and eversion for subtalar movements, and refers to abduction and adduction as movements of the forefoot. He uses supination in the same sense as Lauge-Hansen, i.e. a combined inversion and adduction movement, and pronation as the opposite movement.

Gray's Anatomy describes inversion and eversion as movements of the subtalar (talocalcaneal) joint, and emphasizes the point that full inversion is possible only with the foot fully plantar flexed. Likewise, full eversion is possible only on maximal dorsiflexion of the ankle. Thus, inversion and eversion (maximal range) are movements which can occur only while the foot is not in contact with the bearing surface. Gray refers to supination and pronation as occurring during the stance phase of walking, and as positions adopted by the forefoot relative to the hindfoot. In other words, supination and pronation are components of inversion and eversion, and not synonymous with these two latter terms.

Lauge-Hansen, on the other hand, regards inversion and eversion as components of supination and pronation, and refers to inversion and eversion as movements of the forefoot. This author's use of terms with regard to ankle fractures is not acceptable, and we reject the 'supination-eversion' type of ankle fracture as a 'forbidden combination of movements' in other words, impossible.
Shortcomings in classifications are yet another controversial score. The classification of Ashhurst and Bromer is inadequate and incomplete in that ligament injuries and diastasis are overlooked; secondly, the fact that a combination of forced movements rather than a forced movement in a single direction is responsible receives scant attention. Thirdly, they do not attribute characteristic features to each of the 3rd-degree fractures in the three major groups.

Lauge-Hansen’s classification is not always applicable to clinical cases, and is in fact based upon experimentally produced injuries on the cadaver. The strange (and unacceptable) use of terms has made this classification a source of confusion.

Although rather long and detailed, Bonnin’s classification is logical and is based on clinical and not experimental material. Accordingly, the cases one sees in practice can easily be assigned to the correct group, and can be logically and reasonably approached from a treatment point of view.

The treatment of individual injuries of the ankle is beyond the scope of this paper. Principles must at all times be observed, thus: prevention of complications; reduction of fracture; restoration of congruous joint surfaces as far as possible; reconstruction of joint stability; immobilization; and restoration of function. When closed methods are inadequate or impractical, open methods of reduction are applied.

CONCLUSIONS

The classification of fractures and dislocations of the ankle joint is based upon the mechanism of injury. The anatomical nature of the lesion can logically be deduced, and treatment can accordingly be planned.

This paper represents an effort to introduce an element of uniformity in the concept and management of injuries of the ankle joint, which are common.

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Books Received


